



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

12. During a summer day it gets hottest right after midday. To meet the electricity demand to run all the air conditioners, which of the following power plants could be started up quickly at noon, provided that they are available?
 - a. Hydroelectric.
 - b. Nuclear.
 - c. Coal.
 - d. All of the above.

13. Given a 100-watt incandescent light bulb. What is the 100 watts a measure of?
 - a. The brightness of the bulb.
 - b. The energy used to light the bulb.
 - c. The electrical power needed to light the bulb.
 - d. All the above.
 - e. None of the above.

14. We now can purchase LED lightbulbs. What does LED stand for?
 - a. Less Energy Delivered.
 - b. Light Energy Delivered.
 - c. Light Emitting Diode.
 - d. Light Energy Diode.

15. What do Nuclear Power Plants, Fossil Fuel Powered Plants, and Hydroelectric Power Plants have in common.
 - a. They all produce waste that is hard to dispose of.
 - b. They all use turbines that turn a generator.
 - c. They all use unrenewable fuels.
 - d. Both a and b above.
 - e. All of the above.

16. Which of the following factors affect the amount of energy stored in the reservoir of a hydroelectric plant?
 - a. The height of the dam.
 - b. The volume of the water in the reservoir.
 - c. The temperature of the water.
 - d. Both a and b above.
 - e. All the above.



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

17. The power in the wind hitting a wind turbine is given by the equation $P = 0.5 \times A \times \rho \times v^3$. What does A stand for?
- The area swept by the blades.
 - The total surface area of the blades.
 - The area cleared in front of the wind turbine.
 - None of the above.
18. Which of the following power plants have no environmental effect.
- Nuclear Power.
 - Coal Power.
 - Hydroelectric Power.
 - Wind Power.
 - None of the above.
19. In the commercial sector what is the largest consumer of electricity?
- Air Conditioning.
 - Cooking in restaurants, fast food, etc.
 - Lighting.
 - Refrigeration.
20. Why do we use AC current in our homes?
- Most of the devices used in the home are more efficient using AC current.
 - Most of the devices used in the home function using AC current.
 - It all has to do with getting the electricity to our home, not the devices in our home.
 - All the above.
 - None of the above.
21. Which of the following is true for a transformer?
- It only works with AC current.
 - It can be used to step up the voltage.
 - It can be used to step down the voltage.
 - All the above.
 - Only b and c above.



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

22. The amount of power loss in a wire depends on which of the following?
- The metal that the wire is made of.
 - The current passing through the wire.
 - The length of the wire.
 - All the above.
 - Only a and b above.
23. In a pump-storage hydroelectric power plant which of the following statements are true?
- During low demand water is pumped to a higher elevation.
 - A separate pump is used to pump the water to the reservoir and a generator is used when the water is released from the reservoir.
 - Only electricity from a hydroelectric plant is used to pump the water.
 - All the above.
 - None of the above.
24. What is the difference between electricity from photovoltaic panels and that from a wind turbine generator?
- Only solar is considered a renewable source.
 - Solar panels generate only direct current.
 - Solar panels are more efficient in generating electricity.
 - All the above.
 - None of the above.
25. What makes a LED bulb more efficient than an incandescent bulb?
- The LED only works on direct current.
 - The LED bulb produces less heat.
 - The LED bulb uses less power to produce the same intensity of light.
 - All the above.
 - Only b and c above.
26. Utility-scale **wind turbines** being manufactured now for the U.S. market have **power** ratings that range from:
- 3.0 – 10.0 megawatts
 - 1.5 – 3.0 megawatts
 - 150 – 300 megawatts
 - 30 – 100 megawatts



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

27. Wind Turbines can generate as much as:

- a. 6 Million kWh annually
- b. 600,000 kWh annually
- c. 600 Million kWh annually
- d. 600 kWh annually

28. The _____ is the SI derived unit of electrical resistance, named after German physicist _____.

- a. Volt and Alessandro Volta
- b. Ohm and Nikola Tessla
- c. Ohm and Georg Simon Ohm
- d. Farad and Michael Farandhoff

29. If Efficiency = P_{out} / P_{in} , where P_{out} = Power output, and P_{in} = Power input.

What is the Power Conversion Efficiency if the Sun delivers 1000 Watts to a Solar Array and it is able to Power no more then a 100 Watt light bulb?

- a. 100%
- b. 50%
- c. 75%
- d. 10%

30. The VRB is a type of flow battery used for utility-scale transmission and distribution energy storage applications. What does the acronym VRB stand for?

- a. Valium Reflux Battery
- b. Vandegraff Redox Battery
- c. Vanadium Redox Battery
- d. VanAllen Reflux Belt

31. Which of the following is the least efficient method of electrical power transmission?

- a. AC
- b. DC
- c. HVDC



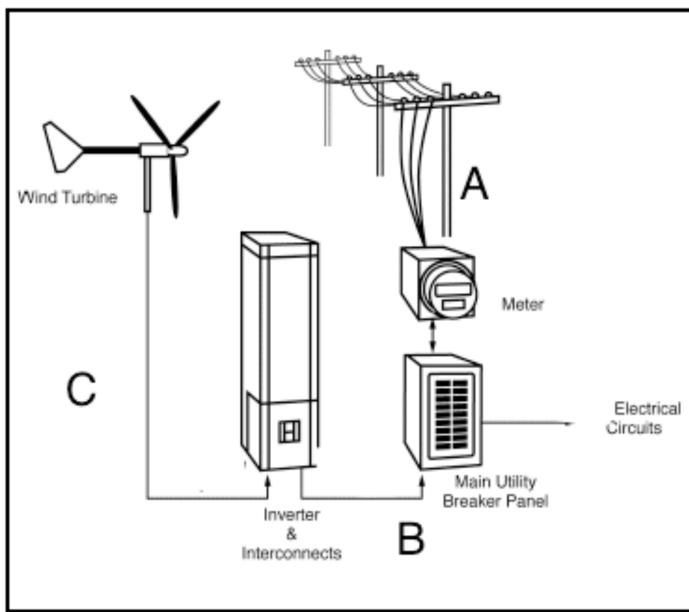
Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

32. Which of the following is NOT an energy storage method?
- a. Batteries
 - b. CAES
 - c. Gravity siphon
 - d. Superconducting magnets
 - e. Steam Accumulator
33. Who Built the first large-scale electricity generating wind turbine in 1888?
- a. Thomas Edison
 - b. Johannes Guusher
 - c. Charles Francis Brush
 - d. Sir Thomas Ayer Tourbinn
34. In 1957 Johannes Juul Erected a 200 kW wind turbine in southeastern Denmark. This three-bladed wind turbine, which for many years was the world's largest, was a major breakthrough in the development of modern wind turbines. What was the name of this wind turbine?
- a. The Geezer wind turbine
 - b. The Guusher wind turbine
 - c. The Gedser wind turbine
 - d. The Juul Wind Turbine of Denmark
35. The SI unit of electromotive force, the difference of potential that would drive one ampere of current against one ohm resistance is known as a:
- a. Joule
 - b. Ampere
 - c. Volt
 - d. Farrad



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

Typical Wind Power Diagram



List the type of Electrical Current type at points A, B, and C in Diagram below
Type of electrical current (AC or DC) at each point:

36. Point A:

- a. DC
- b. AC

37. Point B :

- a. AC
- b. DC

38. Point C:

- a. DC
- b. AC

39. What does the inverter in the Wind Power Diagram do?

- a. It converts DC current to wind energy
- b. It converts AC current to wind energy
- c. It converts DC current to AC current
- d. It makes DC current



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

40. _____ is a method of preventing a wind turbine from spinning too quickly by turning the blades away from the direction of the wind.

- a. Tacking
- b. Crabbing
- c. Steering
- d. Furling
- e. Shifting

41. Electromagnetic generators fall into one of two broad categories:

- a. Dynamos and Dominoes
- b. Alternators and Dynamos
- c. Dominos and Dominators
- d. Alternators and Dominators

42. Two possible advantages of horizontal axis wind turbines are:

- a. The ability to pitch the rotor blades in a storm to minimize damage.
- b. The ability stop the rotor blades when snowing
- c. The ability to place the tower on uneven land or in offshore locations
- d. a and b
- e. a and c
- f. b and c

43. The operating principle of electromagnetic generators states that an electromotive force is generated in an electrical conductor which encircles a varying magnetic flux. This principal is now known as:

- a. Fraudd's Law
- b. Ohm's Law
- c. Faraday's Law
- d. Volta's Law



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

44. Complete the following sentence:

In a generator, alternator, or dynamo the _____ windings generate the electric current.

- a. Immature
- b. Armature
- c. Ammeter
- d. Amateur

45. Any electrical power grid must adapt energy production to energy consumption, both of which vary drastically over time. Which of the following is **NOT** an advantage of adapting energy production and energy consumption?

- a. Fuel-based power plants (i.e. coal, oil, gas, nuclear) can be more efficiently and easily operated at constant production levels.
- b. Because energy from wind is cooler, it is a good alternative air conditioning resource. In reverse mode, it can direct cooler air across a building to reduce the internal temperature.
- c. Electricity generated by (or with the potential to be generated by) intermittent sources can be stored and used later, whereas it would otherwise have to be transmitted for sale elsewhere, or simply wasted.
- d. Vital needs can be met reliably even with no transmission or generation going on while non-essential needs are deferred

46. True or False: The shape and dimensions of the blades of the wind turbine are determined by the aerodynamic performance required to efficiently extract energy from the wind, and by the strength required to resist the forces on the blade.

47. True or False: A wind turbine is designed to produce power over a range of wind speeds. All wind turbines are designed for a maximum wind speed, called the survival speed, above which they will be damaged.



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

Use the following information to answer questions 48 & 49:

A high voltage transmission line with a resistance of $0.19 \Omega/\text{km}$ carries a current of 1300A . The line is at a potential of 765 kV at the power station and carries the current to a city located 124 km from the station. Assume all values are RMS (Root Mean Squared) with only resistive effects.

48. What is the approximate power loss due to the resistance in the line?
- a. 400 MW
 - b. 4000 MW
 - c. 40 MW
 - d. 4 MW
49. What approximate percentage of the power that the line supplies is lost due to resistance?
- a. 4.0%
 - b. 40.0%
 - c. 400.0%
 - d. less than 4.0%
50. Calculate the tip-speed ratio of a wind turbine with 116-ft long blades (232-ft diameter) moving at 12.0 revolutions per minute in a moderate breeze of 16.0 mph. Select the correct answer below.
- a. 621
 - b. 2.10
 - c. 6.21
 - d. 210



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

Team Name: _____ Team Number: _____

Student Names: _____

Answer Sheet:

1. _____	16. _____	31. _____	46. _____
2. _____	17. _____	32. _____	47. _____
3. _____	18. _____	33. _____	48. _____
4. _____	19. _____	34. _____	49. _____
5. _____	20. _____	35. _____	50. _____
6. _____	21. _____	36. _____	
7. _____	22. _____	37. _____	
8. _____	23. _____	38. _____	
9. _____	24. _____	39. _____	
10. _____	25. _____	40. _____	
11. _____	26. _____	41. _____	
12. _____	27. _____	42. _____	
13. _____	28. _____	43. _____	
14. _____	29. _____	44. _____	
15. _____	30. _____	45. _____	Test Score: _____



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

While waiting to be called to demonstrate your CD wind device, you should work *quietly* with your partner and complete this exam. Please neatly print the best answer for each question, on the provided answer sheet.

1. The following are lists of energy sources used to generate electricity in the United States. Which is the correct list from highest to lowest usage?
 - a. Nuclear, Coal, Hydropower, Solar, Wind.
 - b. Nuclear, Coal, Wind, Hydropower, Solar.
 - c. Coal, Nuclear, Hydropower, Solar, Wind.
 - d. **Coal, Nuclear, Hydropower, Wind, Solar.**
 - e. None of the above.
2. Which of the following cities was the first city to be supplied electricity from an electric power plant that is miles from the city?
 - a. Boston, Massachusetts.
 - b. Philadelphia, Pennsylvania.
 - c. **Buffalo, New York.**
 - d. San Francisco, California.
 - e. Las Vegas, Nevada.
3. What is the theoretical maximum power efficiency of any wind turbine generator?
 - a. 35%
 - b. 43%
 - c. 48%
 - d. 59%**
4. Which of the following statements is true?
 - a. The amount of energy that wind carries doubles as its speed increases.
 - b. The amount of energy that wind carries triples as its speed increases.
 - c. The amount of energy that wind carries quadruples as its speed increases.**
 - d. None of the above are true.
5. Which scientist is credited with discovering that a wire moving through a magnetic field produces a current?
 - a. Benjamin Franklin
 - b. Andre Marie Ampere
 - c. Michael Faraday**
 - d. Allesandro Volta



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

6. Which of the following is true?
 - a. Computers work only on AC current.
 - b. **Computers work only on DC current.**
 - c. Computers work using 120 volt power.
 - d. Computers can work on either AC or DC current.
7. Solar panel arrays on the roof of a house:
 - a. Build up heat to generate electricity.
 - b. Send solar power to a generator to be converted into electricity.
 - c. Reflect the heat and gather the electricity in sunlight.
 - d. **Convert solar energy directly into electrical energy.**
8. How are homeowners charged for electricity?
 - a. By the amount of current that is used.
 - b. By the amount of voltage that is used.
 - c. By the amount of power that is used.
 - d. **By the amount of energy that is used.**
9. Which of the following are units of energy?
 - a. Kilowatt-hour
 - b. Kilowatt
 - c. Joule
 - d. **a and c**
 - e. b and c
10. What is the difference between a nuclear power plant and a coal fired power plant?
 - a. **How the water is heated.**
 - b. Nuclear power plant doesn't need a turbine.
 - c. Coal power plant has no pollution.
 - d. None of the above.
11. What type of energy is stored in a hydroelectric plant and then used to generate electricity?
 - a. **Gravitational potential energy.**
 - b. Kinetic energy.
 - c. Hydro-energy.
 - d. Fluid energy.



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

12. During a summer day it gets hottest right after midday. To meet the electricity demand to run all the air conditioners, which of the following power plants could be started up quickly at noon, provided that they are available?
 - a. Hydroelectric.
 - b. Nuclear.
 - c. Coal.
 - d. All of the above.

13. Given a 100-watt incandescent light bulb. What is the 100 watts a measure of?
 - a. The brightness of the bulb.
 - b. The energy used to light the bulb.
 - c. The electrical power needed to light the bulb.
 - d. All the above.
 - e. None of the above.

14. We now can purchase LED lightbulbs. What does LED stand for?
 - a. Less Energy Delivered.
 - b. Light Energy Delivered.
 - c. Light Emitting Diode.
 - d. Light Energy Diode.

15. What do Nuclear Power Plants, Fossil Fuel Powered Plants, and Hydroelectric Power Plants have in common.
 - a. They all produce waste that is hard to dispose of.
 - b. They all use turbines that turn a generator.
 - c. They all use unrenewable fuels.
 - d. Both a and b above.
 - e. All of the above.

16. Which of the following factors affect the amount of energy stored in the reservoir of a hydroelectric plant?
 - a. The height of the dam.
 - b. The volume of the water in the reservoir.
 - c. The temperature of the water.
 - d. Both a and b above.
 - e. All the above.



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

17. The power in the wind hitting a wind turbine is given by the equation $P = 0.5 \times A \times \rho \times v^3$. What does A stand for?
- The area swept by the blades.**
 - The total surface area of the blades.
 - The area cleared in front of the wind turbine.
 - None of the above.
18. Which of the following power plants have no environmental effect.
- Nuclear Power.
 - Coal Power.
 - Hydroelectric Power.
 - Wind Power.
 - None of the above.**
19. In the commercial sector what is the largest consumer of electricity?
- Air Conditioning.
 - Cooking in restaurants, fast food, etc.
 - Lighting.**
 - Refrigeration.
20. Why do we use AC current in our homes?
- Most of the devices used in the home are more efficient using AC current.
 - Most of the devices used in the home function using AC current.
 - It all has to do with getting the electricity to our home, not the devices in our home.**
 - All the above.
 - None of the above.
21. Which of the following is true for a transformer?
- It only works with AC current.
 - It can be used to step up the voltage.
 - It can be used to step down the voltage.
 - All the above.**
 - Only b and c above.



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

22. The amount of power loss in a wire depends on which of the following?
- The metal that the wire is made of.
 - The current passing through the wire.
 - The length of the wire.
 - All the above.
 - Only a and b above.
23. In a pump-storage hydroelectric power plant which of the following statements are true?
- During low demand water is pumped to a higher elevation.
 - A separate pump is used to pump the water to the reservoir and a generator is used when the water is released from the reservoir.
 - Only electricity from a hydroelectric plant is used to pump the water.
 - All the above.
 - None of the above.
24. What is the difference between electricity from photovoltaic panels and that from a wind turbine generator?
- Only solar is considered a renewable source.
 - Solar panels generate only direct current.
 - Solar panels are more efficient in generating electricity.
 - All the above.
 - None of the above.
25. What makes a LED bulb more efficient than an incandescent bulb?
- The LED only works on direct current.
 - The LED bulb produces less heat.
 - The LED bulb uses less power to produce the same intensity of light.
 - All the above.
 - Only b and c above.
26. Utility-scale **wind turbines** being manufactured now for the U.S. market have **power** ratings that range from:
- 3.0 – 10.0 megawatts
 - 1.5 – 3.0 megawatts
 - 150 – 300 megawatts
 - 30 – 100 megawatts



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

27. Wind Turbines can generate as much as:

- a. 6 Million kWh annually
- b. 600,000 kWh annually
- c. **600 Million kWh annually**
- d. 600 kWh annually

28. The _____ is the SI derived unit of electrical resistance, named after German physicist _____.

- a. Volt and Alessandro Volta
- b. Ohm and Nikola Tessla
- c. **Ohm and Georg Simon Ohm**
- d. Farad and Michael Farandhoff

29. If Efficiency = P_{out} / P_{in} , where P_{out} = Power output, and P_{in} = Power input.

What is the Power Conversion Efficiency if the Sun delivers 1000 Watts to a Solar Array and it is able to Power no more then a 100 Watt light bulb?

- a. 100%
- b. 50%
- c. 75%
- d. **10%**

30. The VRB is a type of flow battery used for utility-scale transmission and distribution energy storage applications. What does the acronym VRB stand for?

- a. Valium Reflux Battery
- b. Vandegraff Redox Battery
- c. **Vanadium Redox Battery**
- d. VanAllen Reflux Belt

31. Which of the following is the least efficient method of electrical power transmission?

- a. AC
- b. **DC**
- c. HVDC



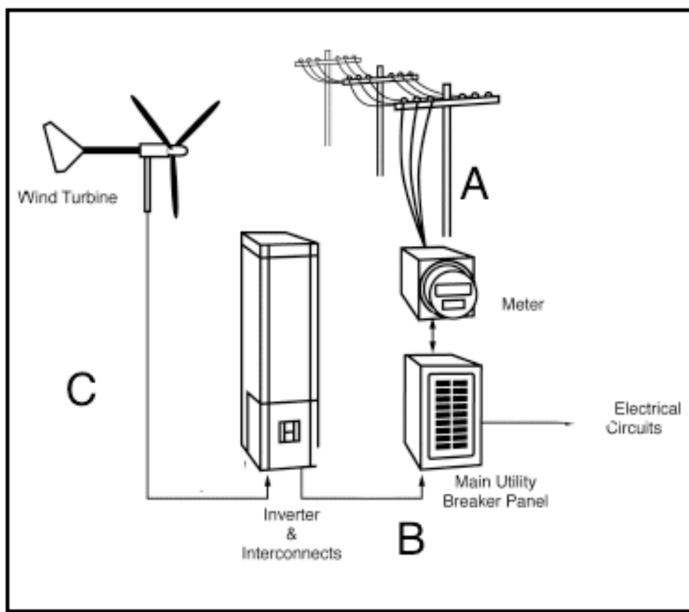
Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

32. Which of the following is NOT an energy storage method?
- a. Batteries
 - b. CAES
 - c. Gravity siphon
 - d. Superconducting magnets
 - e. Steam Accumulator
33. Who Built the first large-scale electricity generating wind turbine in 1888?
- a. Thomas Edison
 - b. Johannes Guusher
 - c. Charles Francis Brush
 - d. Sir Thomas Ayer Tourbinn
34. In 1957 Johannes Juul Erected a 200 kW wind turbine in southeastern Denmark. This three-bladed wind turbine, which for many years was the world's largest, was a major breakthrough in the development of modern wind turbines. What was the name of this wind turbine?
- a. The Geezer wind turbine
 - b. The Guusher wind turbine
 - c. The Gedser wind turbine
 - d. The Juul Wind Turbine of Denmark
35. The SI unit of electromotive force, the difference of potential that would drive one ampere of current against one ohm resistance is known as a:
- a. Joule
 - b. Ampere
 - c. Volt
 - d. Farrad



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

Typical Wind Power Diagram



List the type of Electrical Current type at points A, B, and C in Diagram below
Type of electrical current (AC or DC) at each point:

36. Point A:

- a. DC
- b. AC

37. Point B :

- a. AC
- b. DC

38. Point C:

- a. DC
- b. AC

39. What does the inverter in the Wind Power Diagram do?

- a. It converts DC current to wind energy
- b. It converts AC current to wind energy
- c. **It converts DC current to AC current**
- d. It makes DC current



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

40. _____ is a method of preventing a wind turbine from spinning too quickly by turning the blades away from the direction of the wind.

- a. Tacking
- b. Crabbing
- c. Steering
- d. **Furling**
- e. Shifting

41. Electromagnetic generators fall into one of two broad categories:

- a. Dynamos and Dominoes
- b. **Alternators and Dynamos**
- c. Dominos and Dominators
- d. Alternators and Dominators

42. Two possible advantages of horizontal axis wind turbines are:

- a. The ability to pitch the rotor blades in a storm to minimize damage.
- b. The ability stop the rotor blades when snowing
- c. The ability to place the tower on uneven land or in offshore locations
- d. a and b
- e. **a and c**
- f. b and c

43. The operating principle of electromagnetic generators states that an electromotive force is generated in an electrical conductor which encircles a varying magnetic flux. This principal is now known as:

- a. Fraudd's Law
- b. Ohm's Law
- c. **Faraday's Law**
- d. Volta's Law



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

44. Complete the following sentence:

In a generator, alternator, or dynamo the _____ windings generate the electric current.

- a. Immature
- b. **Armature**
- c. Ammeter
- d. Amateur

45. Any electrical power grid must adapt energy production to energy consumption, both of which vary drastically over time. Which of the following is **NOT** an advantage of adapting energy production and energy consumption?

- a. Fuel-based power plants (i.e. coal, oil, gas, nuclear) can be more efficiently and easily operated at constant production levels.
- b. **Because energy from wind is cooler, it is a good alternative air conditioning resource. In reverse mode, it can direct cooler air across a building to reduce the internal temperature.**
- c. Electricity generated by (or with the potential to be generated by) intermittent sources can be stored and used later, whereas it would otherwise have to be transmitted for sale elsewhere, or simply wasted.
- d. Vital needs can be met reliably even with no transmission or generation going on while non-essential needs are deferred

46. **True** or False: The shape and dimensions of the blades of the wind turbine are determined by the aerodynamic performance required to efficiently extract energy from the wind, and by the strength required to resist the forces on the blade.

47. **True** or False: A wind turbine is designed to produce power over a range of wind speeds. All wind turbines are designed for a maximum wind speed, called the survival speed, above which they will be damaged.



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

Use the following information to answer questions 48 & 49:

A high voltage transmission line with a resistance of $0.19 \Omega/\text{km}$ carries a current of 1300A . The line is at a potential of 765 kV at the power station and carries the current to a city located 124 km from the station. Assume all values are RMS (Root Mean Squared) with only resistive effects.

48. What is the approximate power loss due to the resistance in the line?
- a. 400 MW
 - b. 4000 MW
 - c. **40 MW**
 - d. 4 MW
49. What approximate percentage of the power that the line supplies is lost due to resistance?
- a. **4.0%**
 - b. 40.0%
 - c. 400.0%
 - d. less than 4.0%
50. Calculate the tip-speed ratio of a wind turbine with 116-ft long blades (232-ft diameter) moving at 12.0 revolutions per minute in a moderate breeze of 16.0 mph . Select the correct answer below.
- a. 621
 - b. 2.10
 - c. **6.21**
 - d. 210



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016

Team Name: _____ Team Number: _____

Student Names: _____

Answer Sheet:

1. _____	16. _____	31. _____	46. _____
2. _____	17. _____	32. _____	47. _____
3. _____	18. _____	33. _____	48. _____
4. _____	19. _____	34. _____	49. _____
5. _____	20. _____	35. _____	50. _____
6. _____	21. _____	36. _____	
7. _____	22. _____	37. _____	
8. _____	23. _____	38. _____	
9. _____	24. _____	39. _____	
10. _____	25. _____	40. _____	
11. _____	26. _____	41. _____	
12. _____	27. _____	42. _____	
13. _____	28. _____	43. _____	
14. _____	29. _____	44. _____	
15. _____	30. _____	45. _____	Test Score: _____



Wind Power, Division B
Science Olympiad National Tournament, University of Wisconsin Stout
May 21, 2016